Heriot Watt Course Catalogue

School of Mathematics and Computer Science (MACS) including Computer Science, Information Systems, Software Engineering, Mathematics, and Actuarial Science.

Email KEI (info@KEIabroad.org) if you need syllabi for courses. Make sure to include the course numbers and titles in your email.

School: MACS **Level 1** **Semester: Fall**
Course Code: F17CC1 **Course Title: Algebra A**

Algebra A aims to provide a bridge between school and university algebra, and to provide a firm foundation for further study in mathematics. In this course, the uses and properties of different kinds of numbers will be introduced including some simple number theory, the properties of the reals, and an introduction to complex numbers. Applications of complex numbers will be developed and applied to the study of polynomials; these have applications in calculus. The arithmetic and algebra of matrices will be introduced from scratch together with the properties of determinants with a view to applications in linear algebra. Finally, vectors will be studied and used to solve some simple problems in geometry. This course will also provide an introduction to mathematical language and thinking and will be punctuated with historical digressions to provide a context for the mathematics and to help motivate it.

School: MACS **Level 1** **Semester: Fall**
Course Code: F17CA1 **Course Title: Calculus A**

Calculus A provides a course on differential calculus with applications of differentiation and an introduction to integral calculus. It is designed for students who will specialize in mathematics, actuarial mathematics or statistics. The course builds on what the students learned at school but provides a greater depth of study and introduces new material and concepts.

School: MACS **Level 1** **Semester: Fall**
Course Code: F27IS **Course Title: Interactive Systems**

Interactive Systems give students an opportunity to explore current technological media and creative approaches. The course give students an opportunity to reflect on their learning and progress while working on creative elements of computing including web and game design.

School: MACS **Level 1** **Semester: Fall**
Course Code: F77SA **Course Title: Introduction to Statistical Science A**

Introduction to Statistical Science A aims to provide an introduction to the statistical issues associated with the collection, description, and interpretation of data. In addition, this course aims to introduce statistical computing with a view to describing data using various graphical and numerical methods.

School: MACS **Level 1** **Semester: Fall**
Course Code: F17SI1 **Course Title: Introductory Mathematics**

Introductory Mathematics provides an introduction to mathematics for those who wish to pursue a wide range of studies such as science, engineering and economics. It is aimed at students who have not specialised in mathematics. Much of the course is concerned with algebraic manipulation and solving equations. This is vital for later topics and other areas of study, since the development of algebraic skills is important.

School: MACS Level 1 Semester: Fall
Course Code: F17LP1 Course Title: Logic and Proof

Logic and Proof is an introduction to first order logic for mathematicians and computer scientists. There are three components to this course: proofs, propositional logic and predicate logic. Proofs are the basis of mathematics --- how do we know what we say is true? --- and also of computer science --- how do I know this program will do what I think it will do? Propositional logic and predicate logic are the two ingredients of first-order logic. Propositional logic deals with proofs that can be analysed in terms of words

School: MACS Level 1 Semester: Fall
Course Code: F17XA1 Course Title: Mathematics for Engineers and Scientists 1

Mathematics for Engineers and Scientists 1 seeks to provide students of numerate disciplines in their first year in the university with a range of techniques in Algebra, Calculus and Probability which equip them to tackle problems in their own subject area. The course also provides a foundation in mathematics for more advanced courses in mathematics in later years.

School: MACS Level 1 Semester: Fall
Course Code: F17SG1 Course Title: Mathematics for Scientists 1

Mathematics for Scientists 1 aims to teach basic mathematics relevant to biology and chemistry. The material is highly applications-oriented and example calculations will be used widely.

School: MACS Level 1 Semester: Fall
Course Code: F27PX Course Title: Praxis

Praxis Is an introductory course instructing students in undertaking self-directed study and presenting their findings. The course also familiarises students with the department's wider work and computer systems they will use along with deepening their understanding of the degree courses for which they are registered.

School: MACS Level 1 Semester: Fall
Course Code: F27SA Course Title: Software Development 1

Software Development 1 introduces the object-oriented paradigm and the use of an object-oriented language.

School: MACS Level 1 Semester: Spring
Course Code: F17CB2 Course Title: Calculus B

Calculus B builds on the differential and integral calculus previously studied, before moving on to introduce the basics of mathematical modelling techniques using first and second order ordinary differential equations. The course develops integration methods such as integration by parts and reduction formulae and describes applications of integration including general areas under a curve. Solution methods for first and second order differential equations are introduced and used to investigate various physical problems.

School: MACS **Level 1** **Semester: Spring**
Course Code: F27CS **Course Title: Introduction to Computer Systems**

Introduction to Computer Systems introduces students to modern computer systems architecture and gives students an appreciation of logical design and data representation.

School: MACS **Level 1** **Semester: Spring**
Course Code: F77SB **Course Title: Introduction to Statistical Science B**

Introduction to Statistical Science B aims to develop discrete probability models for data and to understand important features of these models.

School: MACS **Level 1** **Semester: Spring**
Course Code: F17XB2 **Course Title: Mathematics for Engineers and Scientists 2**

Mathematics for Engineers and Scientists 2 is a Level 1 course providing students with a range of techniques in Algebra and Calculus which equip them to tackle problems in their own subject area. The course also provides a foundation in mathematics for more advanced courses in later years.

School: MACS **Level 1** **Semester: Spring**
Course Code: F17SH2 **Course Title: Mathematics for Scientists 2**

Mathematics for Scientists 2 seeks to introduce students of science studying at Level 1 to calculus, vectors and complex numbers, and to show how these areas of mathematics are used in the natural sciences.

School: MACS **Level 1** **Semester: Spring**
Course Code: F17GA2 **Course Title: Problem Solving**

Problem Solving is designed to give students the opportunity to tackle a variety of problems involving elementary mathematics and to use Maple as a tool for applying mathematics and performing mathematical experiments. Students will also be expected to work as a member of a team, produce written reports, and make and deliver presentations.

School: MACS **Level 1** **Semester: Spring**
Course Code: F77PD **Course Title: Professional Development Planning**

Professional Development Planning aims to introduce students to actuarial, statistical and financial mathematics professions and to improve their career planning. It is designed to help students build up a range of skills that will prepare them to cope well at the job interview stage and beyond.

School: MACS **Level 1** **Semester: Spring**
Course Code: F27SB **Course Title: Software Development 2**

Software Development 2 imparts further techniques of object orientation and introduced simple data structures and algorithms.

School: MACS **Level 1** **Semester: Spring**
Course Code: F27SG **Course Title: Software Development 3**

Software Development 3 develops further skills and techniques in programming in a high-level language.

School: MACS **Level 1** **Semester: Spring**
Course Code: F27TS **Course Title: Technology in Society**

Technology in Society explores a range of issues concerning the impact of technology on society. It uses fiction, both writing and film, as a means of provoking and expressing debate. Students will read and critically assess novels, short stories and films which describe questions and issues in this field. In reports, small group discussions and stories of their own, students will explore ways of expressing complex ideas in fictionalised form.

School: MACS **Level 1** **Semester: Spring**
Course Code: F27WD **Course Title: Web Design and Databases**

Web Design and Databases develops knowledge and understanding of fundamental web design concepts and combines these with database structuring and querying techniques to apply this knowledge by implementing an easy-to-use website.

School: MACS **Level 2** **Semester: Fall**
Course Code: F78AA **Course Title: Actuarial & Financial Mathematics A**

Actuarial & Financial Mathematics A aims to provide students with an introduction to the basic concepts and models of financial mathematics.

School: MACS **Level 2** **Semester: Fall**
Course Code: F18AA1 **Course Title: Applied Mathematics A**

Applied Mathematics A aims to explain the basic principles of Newtonian mechanics and to show how this theory describes a range of physical phenomena.

School: MACS **Level 2** **Semester: Fall**
Course Code: F28DA **Course Title: Data Structures and Algorithms**

Data Structures and Algorithms introduces core algorithms and data structures used in a wide range of applications in Computer Science and the development of medium sized programs.

School: MACS **Level 2** **Semester: Fall**
Course Code: F28IN **Course Title: Interaction Design**

Interaction Design aims to give students the opportunity to develop a broad knowledge and understanding of requirements gathering, design and evaluation theory and techniques in interaction design. The course will also introduce commonly used design techniques and pattern for

user interfaces as well as a selection of routine skills and methods involved in working with users.

School: MACS Level 2 Semester: Fall
Course Code: F28IT Course Title: Internet and Communications

Internet and Communications aims to build an appreciation of the structure, organisation and standards of Internet and some key applications such as web and email. The course will also impart basic design and application development skills for the web, and give an understanding of basic data communication protocols and routing techniques in computer networks.

School: MACS Level 2 Semester: Fall
Course Code: F19CF1 Course Title: Linear Algebra

Linear Algebra aims to provide sufficient knowledge of matrix theory and of the solution of systems of linear equations for use in later courses in mathematics and statistics; to give an understanding of the basic concepts of linear algebra; and to develop the ability to solve problems and prove theorems involving these concepts.

School: MACS Level 2 Semester: Fall
Course Code: F18GD1 Course Title: Mathematics for Direct Entrants

Mathematics for Direct Entrants is designed to assist students to get to grips with second year Mathematics, by reviewing material from first year that they may have not covered in their school syllabus. The precise topics covered will vary from student to student, depending on background. For this reason much of the course will be self-taught by directed reading, handout material etc., backed up by direct teaching in small groups.

School: MACS Level 2 Semester: Fall
Course Code: F17XC1 Course Title: Mathematics for Engineers and Scientists 3

Mathematics for Engineers and Scientists 3 aims to provide the necessary mathematical tools for Level 2 science and engineering courses. It builds on the first year mathematics courses for engineers and scientists.

School: MACS Level 2 Semester: Fall
Course Code: F18CD1 Course Title: Multivariable Calculus and Real Analysis A

Multivariable Calculus and Real Analysis A aims to provide an introduction to the calculus for functions of several variables, which will provide sufficient expertise for use in various later courses. The students will also develop their general skills in differentiation, integration and algebraic manipulation.

School: MACS Level 2 Semester: Fall
Course Code: F78PA Course Title: Probability & Statistics A

Probability & Statistics A aims to develop the tools of probability theory with a view to applications in statistical inference and actuarial science. The course also provides an introduction to computer

simulation in R and its applications to probability and statistics.

School: MACS Level 2 Semester: Fall
Course Code: F28PL Course Title: Programming Languages

Programming Languages aims to give students an understanding of different language paradigms and of defining concepts of programming languages. Students will also develop skills in programming in languages from key paradigms.

School: MACS Level 2 Semester: Spring
Course Code: F78AB Course Title: Actuarial & Financial Mathematics B

Actuarial & Financial Mathematics B introduces the student to more advanced mathematical models of cashflows accumulated or discounted at interest, and to develop skill in applying these models to real financial contracts and transactions. The course also introduces simple survival models and associated life tables and moments of cashflows.

School: MACS Level 2 Semester: Spring
Course Code: F28CD Course Title: Creative Design Project

Creative Design Project aims to consolidate multimedia design, prototyping and implementation skills through a realistic project. Students will also develop an appreciation and experience of group processes.

School: MACS Level 2 Semester: Spring
Course Code: F28DM Course Title: Database Management Systems

Database Management Systems familiarises students with the principles of database management systems, to enable them to design and implement databases for specific applications and to integrate databases with application programs.

School: MACS Level 2 Semester: Spring
Course Code: F17SC2 Course Title: Discrete Mathematics

Discrete Mathematics aims to provide an introduction to Set Algebra, Combinatorics, Probability Theory, Graph Theory, Recurrence Relations, and Matrices, for students studying Computer Science or Mathematics degree programmes.

School: MACS Level 2 Semester: Spring
Course Code: F28FS Course Title: Formal Specification

Formal Specification introduces students to specification of programs in a formal logical language (Z), and demonstrate the path from this to programs in a programming language (SML).

School: MACS Level 2 Semester: Spring
Course Code: F17XD2 Course Title: Mathematics for Engineers and Scientists 4

Mathematics for Engineers and Scientists 4 aims to provide the necessary mathematical tools from Linear Algebra, Laplace Transform theory, Analytic Geometry and the use of MATLAB computer program for Level 2 science and engineering courses. It builds on the previous Mathematics for Engineers and Scientists 1-3 courses.

School: MACS Level 2 Semester: Spring
Course Code: F18CE2 Course Title: Multivariable Calculus and Real Analysis B

Multivariable Calculus and Real Analysis B aims to introduce students to the idea of rigorous mathematical arguments and, in particular, to discuss the rigorous foundations of calculus. An important feature of the course is the use of careful, rigorous proofs of the theorems used and one of the aims of the course is to improve student's ability to understand such arguments and to develop such proofs for themselves. A central concept in analysis is the idea of convergence, either of sequences, series or of functions, and this course aims to introduce this concept and provide the basic results which will be used in later courses. In addition, it will give methods of obtaining inequalities and approximations (with precise estimates of how good the approximations are), tests for convergence of series and power series and ways of identifying functions defined by power series and characterisations of functions (over bounded and unbounded intervals) for which the concept of area under the graph of a function makes sense.

School: MACS Level 2 Semester: Spring
Course Code: F18NA2 Course Title: Numerical Analysis A

Numerical Analysis A gives an introduction to some of the basic methods of numerical analysis and the scientific computing package Matlab.

School: MACS Level 2 Semester: Spring
Course Code: F78PB Course Title: Probability & Statistics B

Probability & Statistics B aims to reinforce basic ideas related to the description and analysis of data, and provide the basis for the application of statistical modelling, estimation, hypothesis testing and regression.

School: MACS Level 2 Semester: Spring
Course Code: F18PA2 Course Title: Pure Mathematics A

Pure Mathematics A offers an introduction to the ideas of number theory and geometry to students specialising in Mathematics. Technical skills acquired at Level 1 will be applied to develop the ideas of these two vital strands of mathematical thought, and to offer further insights into mathematical reasoning and the art of proof in a concrete setting

School: MACS Level 2 Semester: Spring
Course Code: F78SC Course Title: Statistics for Science

Statistics for Science is an introduction to some basic statistical techniques. Examples will usually be taken from science, but the methods are much more generally useful.

School: MACS **Level 2** **Semester: Spring**
Course Code: F27WD **Course Title: Web Design and Database Systems**

Web Design and Database Systems develops knowledge and understanding of fundamental web design concepts and combine these with database structuring and querying techniques applying this knowledge by implementing an easy-to-use website.

School: MACS **Level 3** **Semester: Fall**
Course Code: F19PL1 **Course Title: Abstract Algebra**

Abstract Algebra aims to provide an introduction to abstract algebra, covering the basics of groups, rings and fields

School: MACS **Level 3** **Semester: Fall**
Course Code: F29AI **Course Title: Artificial Intelligence and Intelligent Agents**

Artificial Intelligence and Intelligent Agents introduces the fundamental concepts and techniques of AI, including planning, search and knowledge representation as well as the scope, subfields and applications of AI. Students will also develop skills in AI programming in an appropriate language.

School: MACS **Level 3** **Semester: Fall**
Course Code: F29GR **Course Title: Computer Graphics**

Computer Graphics introduces fundamental Computer Graphics theory and programming. Topics include: 2&3D transformations, Texture mapping, Modelling and instantiation, and Hierarchical modelling and scene graphs

School: MACS **Level 3** **Semester: Fall**
Course Code: F29CT **Course Title: Critical and Computational Thinking**

Critical and Computational Thinking aims to give students the opportunity to develop general thinking skills including assessing credibility of evidence, assessing and developing arguments. Student will also learn about applying the techniques of abstraction, modelling and algorithmic solutions to a wide range of problems, particularly those relevant to information systems and organisations.

School: MACS **Level 3** **Semester: Fall**
Course Code: F29FA **Course Title: Foundations 1**

Foundations 1 gives an introduction to and an appreciation of the basic principles and techniques of logic and proof fundamental to Computer Science. The course also introduces the λ-calculus, how computable functions are represented in the λ-calculus, basic theoretical properties of the λ-calculus, and the relevanceof the λ-calculus to computer science.

School: MACS **Level 3** **Semester: Fall**
Course Code: F29KM **Course Title: Knowledge Management**

Knowledge Management provides students with an overview of information and knowledge management in organisations and to critically evaluate a range of methods used to develop strategies for information and knowledge management. Students will also examine the role that knowledge and users play in the learning organisation and learn to critically evaluate the value of knowledge and IT for competitive advantage.

School: MACS Level 3 Semester: Fall
Course Code: F70LA Course Title: Life Insurance Mathematics A

Life Insurance Mathematics A aims to consider some more general models for mortality, and to introduce life insurance policies. Students will also be introduced to the calculation of premiums and the calculation of policy values, and throughout the course will develop their understanding of these areas.

School: MACS Level 3 Semester: Fall
Course Code: F79PA Course Title: Portfolio Theory & Asset Models

Portfolio Theory & Asset Models introduces asset pricing and portfolio selection models. This course covers the first half of the material in Subject CT8 of the Institute/Faculty of Actuaries examinations.

School: MACS Level 3 Semester: Fall
Course Code: F19GB1 Course Title: Project Prepartion and Skills

Project Prepartion and Skills introduces the student to a range of useful skills for carrying out an extended academic project and for future employment.

School: MACS Level 3 Semester: Fall
Course Code: F19PB1 Course Title: Pure Mathematics B

Pure Mathematics B introduces some basic concepts of Discrete Mathematics including: Counting Arguments, Number Theory, and Permutation groups.

School: MACS Level 3 Semester: Fall
Course Code: F29SO Course Title: Software Engineering

Software Engineering equips students with knowledge and skills for the effective management of a group project which encompasses the software development lifecycle. The course also builds students understanding, knowledge and skills in teamwork, software development in groups, and project planning. Students will develop a broader understanding of the interrelationship of development life-cycles and a critical capability in the selection of tools and methods to support project planning, systems analysis, requirements capture, and system specification.

School: MACS Level 3 Semester: Fall
Course Code: F79MA Course Title: Statistical Models A

Statistical Models A describes and compares the main approaches to statistical inference: including classical and Bayesian, and to develop students' skills in practical, computer- based estimation and

inference. This course also aims to develop students' independent research skills, and their report writing skills.

School: MACS Level 3 Semester: Fall
Course Code: F79PS Course Title: Statistics for Social Science

Statistics for Social Science aims to introduce students to the main classical statistical methods that are commonly applied in psychology and other social sciences and to give hands-on experience of using more advanced techniques for exploring multivariate data.

School: MACS Level 3 Semester: Fall
Course Code: F79SP Course Title: Stochastic Processes

Stochastic Processes aims to introduce fundamental stochastic processes which are useful in insurance, investment and stochastic modelling, and to develop techniques and methods for analysing the long term behaviour of these processes.

School: MACS Level 3 Semester: Fall
Course Code: F19MV1 Course Title: Vector Analysis

Vector Analysis introduces and develops the methods of vector analysis. These methods provide a natural aid to the understanding of geometry and some physical concepts. They are also a fundamental tool in many theories of Applied Mathematics.

School: MACS Level 3 Semester: Spring
Course Code: F19AB2 Course Title: Applied Mathematics B

Applied Mathematics B introduces some fundamental ideas and techniques in Applied Mathematics.

School: MACS Level 3 Semester: Spring
Course Code: F79BI Course Title: Bayesian Inference & Computational Methods

Bayesian Inference & Computational Methods aims to provide students with a knowledge of modern Bayesian Statistical inference, an understanding of the theory and application of stochastic simulation methods including MCMC, and experience of implementing the Bayesian approach in practical situations.

School: MACS Level 3 Semester: Spring
Course Code: F19MC2 Course Title: Complex Analysis

Complex Analysis aims to provide an understanding of the basic facts of complex analysis, in particular the nice properties enjoyed by the derivatives and integrals of functions of a complex variable, and to show how complex analysis can be used to evaluate real integrals. The course also aims to provide an understanding of the basic concepts in analysis in the context of metric spaces showing how these ideas are generalisations of the ideas used in Real Analysis and to improve the students abilities in mathematical reasoning and in expressing themselves accurately in writing by producing correct mathematical proofs.

School: MACS **Level 3** **Semester: Spring**
Course Code: F79DF **Course Title: Derivative Markets and Discrete-time Finance**

Derivative Markets and Discrete-time Finance introduces the idea of derivative securities and why they exist, explaining the role of forward and option contracts in risk management. The concept of arbitrage free pricing (cash-and-carry pricing) is explained and developed into the fundamental theorem of asset pricing in discrete time. Pricing on the binomial tree (the CRR model) is explained, for both European and American style derivatives, in the context of the fundamental theorem and the relationship between the CRR model and the continuous time Black-Scholes-Merton formula discussed. The fundamental properties of option prices are given.

School: MACS **Level 3** **Semester: Spring**
Course Code: F29FB **Course Title: Foundations 2**

Foundations 2 further introduces basic notions of computability, including the understanding of two models of computability: the lambda-calculus and Turing machines, and gaining knowledge of which functions can be computed.

School: MACS **Level 3** **Semester: Spring**
Course Code: F70LB **Course Title: Life Insurance Mathematics B**

Life Insurance Mathematics B introduces some more advanced topics in life insurance mathematics. Topics include: Thiele's differential equation, Markov multiple-state models, risk reserves, insurances written on multiple lives, profit testing conventional insurance contracts, and profit testing unit-linked contracts.

School: MACS **Level 3** **Semester: Spring**
Course Code: F19NB2 **Course Title: Numerical Analysis B**

Numerical Analysis B aims to provide an introduction to function approximation and interpolation methods in 1-- and 2--D; to study the techniques required to apply and analyse numerical methods for solving linear systems of equations and eigenvalue problems. By the end of the course, students should be able to apply the methods and algorithms listed below, and carry out the associated analysis of errors, convergence and operations counts.

School: MACS **Level 3** **Semester: Spring**
Course Code: F29OC **Course Title: Operating Systems & Concurrency**

Operating Systems & Concurrency provides an introduction to operating systems, their basic principles and shell programming, the course also introduces the theory and practice of concurrent hardware and software systems.

School: MACS **Level 3** **Semester: Spring**
Course Code: F19MO2 **Course Title: Ordinary Differential Equations**

Ordinary Differential Equations aims to give an understanding of linear and nonlinear ordinary differential equations and systems of equations and to show how ordinary differential equations are important in mathematical modelling.

School: MACS Level 3 Semester: Spring
Course Code: F29PD Course Title: Professional Development

Professional Development instils a professional and ethical attitude in students toward the application of computer technology, while introducing methods for the rational resolution of ethical problems. Students will gain an appreciation of the relevant professional and legal requirements concerning computer-based systems, as well as an awareness of the social implications of information technology.

School: MACS Level 3 Semester: Spring
Course Code: F29SS Course Title: Sociotechnical and Soft Systems

Sociotechnical and Soft Systems aims to give students the opportunity to develop an understanding and an ability to apply Checkland and Wilson's Soft Systems Methodology (SSM). As part of this they will be introduced to systems thinking as a means of analysing the whole context of an information system and to the use of techniques such as rich pictures and other diagrammatical notations will be used to allow analysis to incorporate all stakeholders. Practical use of these skills will be developed through exercises based on case studies.

School: MACS Level 3 Semester: Spring
Course Code: F79MB Course Title: Statistical Models B

Statistical Models B aims to develop students' abilities in understanding and solving practical statistical problems, and to teach them how to use appropriate models and techniques for analysing data especially in applications related to linear and generalised linear models.

School: MACS Level 3 Semester: Spring
Course Code: F79SU Course Title: Survival Models

Survival Models aims to provide an understanding of the use of mathematical models of mortality, illness and other life history events in the study of processes of actuarial interest. Students will also learn to estimate the parameters in these models, mainly by maximum likelihood and to apply methods of smoothing observed rates of mortality and to test the goodness-of-fit of the models.